

Prosthetic Arteries

Resection of the Abdominal Aorta and Replacement with Plastic Materials

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DIRECT SURGICAL operation is now an accepted treatment for aneurysmal and obliterative diseases of the abdominal aorta.

Abdominal aortic aneurysm frequently results in death from rupture of the aneurysm. Persons with abdominal aortic aneurysms have a lowered life expectancy.⁴ Without surgical intervention, following perforation of an abdominal aortic aneurysm, the disease is nearly always fatal. Cooley and De-Bakey,¹ Gerbode,⁵ Julian⁶ and Shumacker⁷ have all shown that early surgical intervention can convert a hopeless prognosis into a relatively more favorable one. Wylie⁹ said that whereas the mortality rate for resection and grafting of aneurysms of the abdominal aorta is about 10 per cent if operation is done before rupture of the vessel occurs, it is 50 per cent if delayed until after rupture. In view of the high incidence of eventual rupture, in most instances verification of the existence of an aortic aneurysm is an indication for operation even in the absence of pain.

Most reports of resectional operation on the abdominal aorta indicate that the replacement has nearly always been by use of a homograft. Deterling^{2,3} reported a great deal of investigative work on evaluating synthetic materials and fabrics suitable for blood vessel replacement. He said that, in peripheral arteries, homografts appear to be superior in patients with segmental occlusive disease. Szilagyi⁸ also expressed belief that homografts are still the best arterial substitutes.

It would appear that the most satisfactory use of a synthetic prosthesis would be as a substitute for a segment of a large caliber vessel in a relatively immobile area—the abdominal aorta, for example.

The following cases represent patients in whom synthetic prostheses have been used. The types used were either the Orlon prosthesis developed under the direction of Dr. Paul Sanger, or the Edwards-Tapp seamless prosthesis. In the one case requiring multiple operations, both were used.

CASE 1. The patient, a white man 40 years of age, was admitted to the hospital June 27, 1956, with a diagnosis of obliterative arteriosclerosis of the

• In seven cases, nine operations were done in which arterial replacements made of synthetic fabrics were used. In three cases the operation was entirely elective, and at last report the patients were doing well. In the four other cases there were acutely complicating factors, known before operation, and the patients died although so far as functioning of the prosthetic artery was concerned there was difficulty in only one case—a leak at one of the anastomotic seams. In one case in which the synthetic material was removed after it had been in place some time, the prosthesis showed little effect of foreign body reaction.

terminal aorta. For two years he had had severe cramping pains in both thighs, hips and legs and had been unable to walk far without acute pain. Upon examination, the blood pressure was 130/77 mm. of mercury. The heart was not enlarged. All arterial pulses in both lower extremities were absent.

At operation, advanced atherosclerosis of the terminal aorta and the common iliac arteries was noted. Resection of these vessels was carried out, the proximal extent being just distal to the renal arteries. Retrograde flow was obtained bilaterally, but was less forceful on the left side. A Sanger prosthesis was used, and lumbar sympathectomy was done on the left side. After operation satisfactory arterial pulses were present at all times on the right but not on the left. The patient was discharged, ambulatory, on the fifteenth postoperative day.

The patient continued to have pain in the left lower extremity when walking, but was essentially free of pain in the right leg. It was believed that further operation could give additional relief.

Operation was done in January, 1957, to explore the arterial supply to the left lower extremity and, if possible, to provide improvement. On the left, the artery was found to be obliterated just distal to the prosthesis. The prosthesis substituting for the left common iliac artery was compressed and contained no blood up to the bifurcation. It was possible to open this limb and obtain normal arterial flow through it. An Edwards-Tapp arterial substitute was then sutured to the distal end of the re-opened prosthesis proximally, and was anastomosed end-to-side with the left common femoral artery. Pulses in the left lower extremity then were excel-

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lent. On the fifth postoperative day these pulses suddenly disappeared.

At a third operation a large embolus was found in the left limb of the prosthesis. For fear of compromising the situation on the right (the good side) by attempting complete removal and replacement of the left limb alone, it was decided to resect all the previous prostheses except for the very uppermost portion of the aortic limb. An Edwards-Tapp replacement was then used and extended distally to be anastomosed end-to-side with the common femoral arteries. Good pulses were present bilaterally at the conclusion of the operation. In the immediate postoperative period thrombophlebitis involving the deep venous system of the left lower extremity developed. The patient was discharged from the hospital March 7, 1957, ambulatory and with good arterial pulses in both feet. When examined at intervals later, he had good pulses in both lower extremities, was working, and was remarkably free of symptoms.

The excised prosthesis which had been in use for about seven months was examined microscopically and showed only mild foreign body reaction.

CASE 2. A 73-year-old white man, admitted to hospital September 12, 1956, had a history of pain in the back and mid-abdomen for three months. The blood pressure was 200/100 mm. of mercury. A large pulsating mass was felt in the abdomen. No abnormal calcification or mass was demonstrated by anteroposterior and lateral x-ray views of the abdomen.

At operation a large arteriosclerotic aneurysm of the abdominal aorta was resected. A Sanger prosthesis was used, extending from just distal to the renal arteries to just proximal to the termination of the common iliac arteries. A good retrograde flow was obtained from both iliac arteries. The postoperative course was uneventful and the patient was discharged, ambulatory, on the tenth day. He was examined from time to time afterward, and good arterial circulation to the lower extremities always was present.

CASE 3. A white man 65 years of age was admitted to hospital February 15, 1957, with a history of pain for two months in the lumbar area and radiating into the inguinal regions and thighs. The blood pressure was 160/90 mm. of mercury. Pulses were present in both lower extremities. Radiographs showed dilatation of the lower abdominal aorta with calcification, and dilatation of the common iliac arteries with much calcification. No abnormalities were noted in an electrocardiogram. The nonprotein nitrogen content was within normal limits.

At operation an arteriosclerotic aneurysm involving the distal abdominal aorta, the common iliac arteries and the hypogastric arteries was observed. The external iliac arteries were pliable to palpation and in very decided contrast to the involved vessels. The aneurysm was resected, the

hypogastric arteries were ligated and a Sanger prosthesis was placed between the aorta and the external iliac arteries. The patient left the hospital ambulatory and with good arterial pulses in both lower extremities on the sixteenth postoperative day. He continued to do well.

CASE 4. The patient, a white man 66 years of age, had been under observation as an outpatient for about one year and was known to have an aneurysm of the abdominal aorta, bronchiectasis, pulmonary emphysema and generalized arteriosclerosis. He was admitted to hospital December 26, 1956. The risk of operation in his particular case had been explained to him previously and he had decided against it. On admission, however, he was having much discomfort in the lower extremities, and for several weeks had noted swelling of both lower extremities. It was felt that the swelling was due to vena caval obstruction. The blood pressure was 124/72 mm. of mercury. The patient at this time was eager for surgical treatment in spite of the risk.

At operation, January 2, 1957, a large arteriosclerotic aneurysm of the abdominal aorta with inflammatory reaction involving the common iliac veins and the distal vena cava in a dense compressive mass was observed. The aneurysm was resected and a Sanger replacement used. The patient tolerated the procedure remarkably well and had good pulsations in the lower extremities when it was completed. The swelling in the lower extremities disappeared quickly. On the tenth postoperative day, evisceration of the abdominal wound occurred. Reclosure was carried out and the patient did fairly well for several days. He died on the twenty-fourth postoperative day, however, of bronchopneumonia, pulmonary infarct and jejunal obstruction due to adhesions.

CASE 5. A white man 58 years of age was admitted to the hospital in February, 1957, after having collapsed in a physician's office. He early complained of much abdominal pain and the signs of severe shock were present. A diagnosis of ruptured aortic aneurysm had been made. At the time we were consulted the patient had been in shock for seventeen hours. It appeared that bleeding had stopped and that the most urgent problem was of blood replacement and of determining urinary function. The patient responded to transfusion and there was good urinary output in the next 24 hours. The blood pressure gradually rose to 200 mm. of mercury systolic. The patient suddenly had severe pain again and was suddenly in shock. It was felt that the only hope lay in immediate operation. A ruptured abdominal aortic aneurysm was resected and a Sanger prosthesis was used. At the conclusion of the operation the blood pressure was 120 mm. of mercury systolic and the general condition of the patient was fair. Pulses were present in both lower extremities. The patient's condition, however, did not improve, and he died seven hours after operation. At autopsy, unusually advanced and extensive

generalized arteriosclerosis, pronounced coronary artery atherosclerosis and coronary occlusion with early infarct were noted. There was a leak at the upper junction of the prosthesis and the aorta. The pathologist reported that even if the patient had survived the immediate acute problems, his life expectancy could not have been more than a few months.

CASE 6. The patient, a 71-year-old white man, was first observed in the hospital in March, 1957, with a diagnosis of intra-abdominal hemorrhage due to ruptured aneurysm of the abdominal aorta. The patient was moribund, but both he and his family wished even the slight chance that operation offered. At operation a large ruptured aneurysm was found and resected. An Edwards-Tapp prosthesis was used from the level of the renal arteries to the common femoral arteries. It was necessary to clamp above the renal arteries for 33 minutes. At the conclusion the patient's immediate condition was somewhat better than preoperatively. Then, a urinary shut-down developed and the patient died the following day.

CASE 7. A white man 58 years of age entered the hospital December 5, 1956, with a history of pain in the lower abdomen and back for four months. The pain improved for a time, then became worse a month before admittance to hospital. About two weeks previously a mass had been noted in the right lower quadrant of the abdomen. Upon examination the mass was observed to be nontender and to have no noticeable pulsation. The blood pressure was 186/120 mm. of mercury. In an x-ray film of the chest, redundancy and dilatation of the aorta, particularly the ascending portion of the arch, were noted. At operation an aneurysm of the common iliac arteries and the terminal aorta was observed. Dissection had occurred and a massive hematoma occupied the retroperitoneal space of both lower quadrants of the abdomen and of the entire posterior one-third of the pelvis. The old blood was evacuated and the aneurysm resected. A Sanger prosthesis was used and it functioned well. The postoperative course was uneventful and the patient was discharged, ambulatory and with good pulses in both lower extremities, on the eleventh postoperative day. He returned to work and did well until about six months later, when he was returned to the hospital by ambulance. Shortly after admission he died of massive hemoptysis due to rupture of an intrathoracic aortic aneurysm. At postmortem examination the prosthesis was observed to be intact and functional.

TECHNIQUE

In the operation used in the cases here reported, the anastomosis is made the same as in using a homograft. This consists of one row of continuous 4-0 arterial silk with an occasional interrupted reinforcing suture. It is important that the lumen of the replacement not be allowed to fill with blood

during the period of anastomosis, as clotting will occur and may cause obstruction at some distal area in the arterial tree. There are at least two other technical points of importance. We feel that with the materials that are available at present, the prostheses should be used only as replacements for large arteries located anatomically in a relatively immobile area. In replacing the terminal aorta there is an advantage to be gained by shortening the aortic segment and proportionately lengthening the iliac segments, thereby reducing the angulation of the iliacs at the bifurcation.

COMMENT

In only three of the seven cases presented could operation be called purely elective. The three patients continue to do well. In three of the remaining cases the grave complication of dissection and hemorrhage were factors. In the other case the patient had known pulmonary disease plus the complication of vena caval obstruction.

As yet, insufficient time has elapsed to determine the long range results of the use of prosthetics as large artery replacement material in human patients. Undoubtedly, the ideal material has not yet been produced, although the improvement has been rapid.

There are several advantages of the synthetic replacements. Storage is not a problem and they are readily available. They are easier and faster to use from a technical standpoint. There is reason to believe that extensive tortuosity or dilatation will not develop in them. Certainly they enlarge the geographical horizons for saving life and limb in times of emergency.

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